Circulation Variations in the Strait of Juan de Fuca

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Abstract
Because of the increased interest in the oceanography of the Strait of Juan de Fuca, this paper presented an overview of prior large-scale observations of circulation that are important for the interpretation of studies at smaller scales in space and time and at longer time scales anywhere in the Strait. The observations were made mostly by PMEL / NOAA in Seattle during the 1970s and 1980s, but some were made by IOS in Sydney. Only a brief synopsis is given here. A more thorough summary is in Cannon and Bretschneider (1986), including a list of most of the early references. Cannon et al. (1978) and Holbrook et al. (1980) showed the locations of most of the observations, and Cannon et al. (1990) included some observations in the Strait at the entrance to Admiralty Inlet that effect flow into Puget Sound.

Summary
The Strait of Juan de Fuca is a fjord estuary connecting Puget Sound and Georgia Strait to the Pacific Ocean. Circulation in the Strait is dominantly tidal but has a superimposed estuarine component (averaged over several tidal cycles) that is seaward at the surface and landward at depth. Coastal storms, during any time of year, can cause estuarine flow reversals in the Strait lasting from a few days to more than a week (Holbrook and Halpern 1982). Southerly winds push water against Vancouver Island reversing the sea-surface slope in the Strait. This results in landward intrusion of fresher, warmer surface water and seaward retreat of deep saltier water (Cannon and Bretschneider 1986). Current reversals can occur from the inner most part of the Strait and extend across the continental shelf through the Juan de Fuca Canyon (Cannon 1972; Cannon et al. 1973). Coastal changes also can decrease the salinity at the Admiralty Inlet entrance sill into Puget Sound, and in turn can decrease bottom-water intrusions into the Sound (Cannon et al. 1990). The magnitude of these changes within the Strait and between the Strait and the Pacific Ocean in many cases can exceed both the mean currents and the tidal currents. The relatively large simultaneous salinity variations imply that variations also can occur in other water properties and in the distribution of organisms, and these kinds of variations could greatly alias interpretation of sampling on relatively smaller space and time scales.

Related Studies
Thomson (1994) gave a more recent summary of some of this work. Holbrook and Halpern (1982), and Proehl and Rattray (1984) proposed theoretical explanations for the surface intrusions. Hickey et al. (1991) described another large-scale variation caused by a large lens of Fraser River fresh water that transited the San Juan Islands with minimal mixing. Holbrook et al. (1980) showed little evidence of Fraser water in the eastern Strait of Juan de Fuca. Cannon et al. (1978) described examples of the Fraser River sediment plume transiting into the San Juans but not beyond. Schumacher et al. (1978) described circulation changes within the San Juan Islands.

Recommendation
The main point of this review is that coastal winds can change the estuarine flow and water properties in the Strait on time scales that could influence studies sampled both at shorter time scales in smaller areas and at longer time scales anywhere in the Strait. A corollary is that if sampling only occurs in good weather, important variations may be missed.

It is recommended that all studies include sufficient time-series observations (water properties of interest and currents) to determine aliasing limitations.

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